REMARKS

Claims 2 - 15, 25 - 26, 31 and 38 - 44 remain active in this application. Claims 1, 16 - 24, 27 - 37 and 45 have previously been canceled. New claims 46 and 47, corresponding to claim 30, previously canceled, have been added. No new matter has been introduced into the application.

Summary of the Interview of December 15, 2006

The opportunity for an interview on December 15, 2006, graciously extended by Mr. Boyer D. Ashley to the undersigned, is acknowledged with appreciation, as is Mr. Ashley's evident thoroughness in preparation for the interview. At that interview, the invention and the Baker, Maybon and Islam patents were discussed in detail as will be summarized below. Further, the undersigned displayed portions of a book entitled "Welding and its Application" by Boniface E. Rossi (McGraw-Hill Book Co., 1941), particularly pages 126 - 131, copies of which are attached, as an aid in visualizing the formation of a puddle and thermal mechanics thereof during welding and for the incidental commentary on the production of a rippled face on welds due to the upset of equilibrium of the crater or puddle material due to a difference in surface tension with temperature at different locations within the puddle and which are asserted, in Rossi, to be present in *all* completed welds. It was pointed out in this regard, that while the illustrations of Rossi (which long antedates the development of laser welding but is otherwise believed to be authoritative and well-accepted, particularly since the copy shown to Mr. Ashley was the *eighth* impression of the first edition) correspond to arc welding, the difference in surface tension is indicated to be a function of temperature

without mention of any dependence on the nature of the heat source. In this regard, however, it is respectfully noted that in arc welding, filler material is delivered to the puddle at an elevated temperature and in a partially or fully melted state and is thus, in this regard, somewhat analogous to laser welding where the filler material is directed into and melted or partially melted by the laser energy. Exemplary weaving/scanning patterns preferred for developing a puddle which is, importantly, larger than area of welding heat application and typical weld bead cross-sectional shapes (which are generally relatively flat and not upstanding as is more appropriate for a blade when sufficient heat is applied for good bonding to occur) contained in the Rossi text, were also pointed out to Mr. Ashley. Further, a copy of photographs (attached) comparing welds produced by the invention (Photographs A and B), arc welding (photographs C and D) and plasma arc deposition (photographs E and F) already of record, and similar photographs (G and H) showing a weld produced by melting powder with a laser during powder application and *before* formation of a puddle, in which spattering, incomplete bonding and inconsistent melting were abundantly evident were also shown to Mr. Ashley. It is also evident from photographs G and H that a rippled face of the weld similar to that produced by arc welding and plasma arc deposition (photographs C - F) is also produced using a laser as a heat source for melting powder prior to formation of a puddle but that a rippled face of the weld is not evident in the weld beads produced in accordance with the invention. It was respectfully submitted to Mr. Ashley that the absence of any evident rippling of the face of the weld bead in photographs A and B while rippling is clearly evident in photographs C - H including a weld bead formed by laser welding in photographs G and H, clearly indicates that the absence

of rippling is not attributable to use of a laser, *per se*, and, particularly in view of the mechanics of weld bead ripple formation as discussed by Rossi, is clear evidence that the present invention involves a much different heat transfer regime than is presented in the prior art (and Maybon in particular in which a rippled face of the weld deposit 58 is clearly illustrated in Figures 5 - 7) in addition to the evidence provided by the disclosure in the present application of formation of a weld bead deposit which is of near net shape for the desired die blade (e.g. semi-elliptical and upstanding rather than generally flattened) in accordance with the invention, as has been previously argued.

In essence, as pointed out to Mr. Ashley, while a laser may be preferable to other heat sources such as arc welding and plasma arc deposition for precision welding since it provides improved heat control, application of filler/blade material to the puddle where the blade/filler material is not significantly heated by the heat source/laser provides an additional and highly effective further mechanism of heat control within the puddle and weld bead *and which it appears would be compromised by whatever degree powdered blade/filler material was heated by the laser prior to reaching the puddle*; producing (usually in a single pass) a weld bead having a shape which is much different from the weld bead shape which would otherwise be produced where the filler/blade material is heated before deposition and which is highly advantageous for a die blade as well as having a metallurgy in which the blade/filler material predominates throughout the blade to a greater extent than previously achievable while still achieving an excellent bond to the body material.

It was also pointed out to Mr. Ashley that the inventors need not know or even have a theory as to the

mechanism by which the invention produces such meritorious effects but need only know (and disclose) how to practice the invention to obtain such results, which, as has been amply demonstrated, is highly distinctive as compared with the prior art. Whatever the actual effects engendered by the invention through application of powdered blade/filler material directly to the puddle might be, it is believed reasonable to visualize the process as being fusion of the blade/filler material being limited by heat transfer from the puddle which develops the unique and advantageous weld bead shape corresponding to the temperature profile at a temperature corresponding to the melting point of the blade/filler material as heat is transferred thereto from the puddle and which would appear to account for the apparent absence of ripples in the weld bead face since the temperature and, hence, the surface tension, would be substantially stabilized along such a substantially isothermal contour. Melting of the blade material from heat principally applied from the puddle is also consistent with the advantageously higher proportion of blad/filler material throughout the weld bead/blade, particularly in the upper portions thereof.

In this regard, Mr. Ashley requested that the undersigned address passages of the specification at page 10, lines 17 - 19, page 11, lines 2 - 4, page 16, lines 12 - 13, the amendment to page 11 presented in the response filed February 6, 2002, and the interview summary dated February 4, 2002, (to which interview, the undersigned was not a party) both in the interview and this response to point out how these passages are consistent with application of blade/filler material powder to the puddle and melting of the powder therein and are thus differentiated from direct and simultaneous heating of the die body and the powder by the laser. Initially, it is noted in this regard, that

the invention may evidently be practiced to produce the meritorious effects thereof without the necessity of *total exclusion* of heating of powder by the laser but that it is the distinctive feature of *application of powder to the puddle* (e.g. *which has not been significantly heated directly by the laser*) which appears, from Rossi and the attached comparative photographs, to support the production of the meritorious effects of the invention and that, conversely, the extent to which any proportion of the blade/filler material may be directly heated by the laser appears to reduce the effectiveness of the application of unheated powder to the puddle as a heat control mechanism. By the same token, it is respectfully submitted that a prior art methodology which *relies upon* direct heating of the blase/filler material powder by the laser *teaches directly away from the invention*.

Addressing the above passages of the record of this application in order, page 10, lines 17 - 19, merely indicate that either a side feeder or a coaxial feeder may be used to practice the invention, that a coaxial feeder was deemed preferable and that a suitable side feeder is commercially available. It was pointed out at the interview that a coaxial powder feeder need not direct any powder into the laser beam but could be coaxial with the laser beam while directing powder substantially parallel to the laser beam (e.g. such that it strikes the puddle surface in an annular pattern *surrounding* the laser beam). That is, a feeder which delivers powder directly into the laser beam may be coaxial (or not) with the laser beam but it does *not* logically follow that a feeder *necessarily* introduces powder into the laser beam by virtue of being coaxial therewith, as noted ("the powder material *surrounds*" the laser beam) on page 10 of the remarks appended to the response filed February

6, 2002, which will be discussed below. In this regard, it was also pointed out that the illustrations of the powder trajectory in Figures 1 and 2 of the application shows a powder trajectory which does not intersect the laser beam but appears to be more nearly directed to the die body/puddle surface. It was also pointed out at the interview that claim 30 (directed to a coaxial feeder) had been canceled in view of the potential for confusion in regard to a feeder being coaxial while not directing powder into the laser beam. However, in view of the opportunity occasioned by Mr. Ashley's request to directly address the same, the subject matter of claim 30 has been reinstated above as new claims 46 and 47.

Page 11, lines 2 - 4, conclude the paragraph in which the above-discussed passage appears. These lines read (emphasis added): "The powder feeder 16 is associated with the laser head 10, so as to selectively introduce powder *into the area being clad*, as will be described." It is respectfully submitted that this passage clearly refers to "the area being clad" as distinct from the powder being introduced into the laser beam and appears to be inconsistent with introduction of the powder into the laser beam even though the area on which the laser beam impinges is within "the area being clad". It was also pointed out that on page 11, lines 13 - 14, it is stated with reference to Figure 2 that "the powder 16A is fed into the area being clad by the laser". It is respectfully submitted that this passage, by *twice* making reference to an area which is on the die body and not the laser beam (while otherwise mentioning the laser), directly and unambiguously discloses that the powder is (and should be for optimal successful practice of the invention) directed to the die body surface where the puddle is formed as is, in fact, clearly illustrated in Figure 2, and *not* into the laser beam.

It is also believed to be significant to the proper interpretation of this latter passage to observe that page 11, line 10, states (emphasis added), also with reference to Figure 2, that the "laser beam is *scanned* along the die surface 13A, so as to melt or "puddle" an area 17 in the surface 13A, along a path corresponding to the desired blade pattern" and, in fact, Figure 2, clearly shows puddle or melted area 17 of much larger extent than the area upon which the laser beam impinges at any given point in time. Therefore, the area of the puddle and the area on which the laser beam impinges at any given time *are clearly not the same* although the area on which the beam impinges may be within a portion of the puddle or a portion of the die body where the puddle is *being formed*.

It is respectfully submitted that the repeated language of the specification "into the area being clad" which is "along a path corresponding to the desired die blade pattern" is highly and literally accurate and unambiguously descriptive of where powder must be applied to obtain the meritorious effects of the invention and which thereby patentably distinguishes the invention. Such choice of language clearly does not correspond to and cannot reasonably be interpreted as inferring in any way that powder is directed into the laser beam or heated thereby while accommodating the fact that some powder could, *incidentally*, be directly heated by the laser beam within the scope of the invention although such direct heating would compromise the invention to a similarly incidental degree. In summary, it is the application of the powder to the area of the puddle which corresponds directly to the area being clad which is highly distinctive and characteristic of the invention; *from which the prior art teaches directly away*, as will be discussed below. In this regard, it is also

respectfully called to the Examiner's attention that, from a comparison of Figures 2 - 5 and from Figure 3, in particular, the area of the base of the blade/blade material deposit corresponds to the area of the puddle 17 where the laser has scanned and *not* to the area of impingement of the laser beam at any given instant.

Page 16, lines 12 - 13, simply state: "It should be appreciated that in this invention, a CO_2 laser which (sic) can locally melt die surface and powder." The remainder of the paragraph simply indicates that other types of lasers can be used. This sentence thus merely states that the power generated by the laser should be sufficient that the die surface and the powder both reach their melting temperature in the course of the practice of the invention. Nothing whatever can be inferred from this passage which remotely suggests that the powder is or must be directly melted by the laser. Moreover, the passage cannot reasonably be interpreted as contradicting any portion of the disclosure on page 11 that the powder is applied to the area of the puddle which is "being clad" and formed by "scanning" of the laser; as distinct from the area of the die body being directly heated by the laser at any given time. It is also respectfully submitted that there is no inference of direct melting of the powder in the passage of the specification at page 16, line 19, through page 17, line 4. While line 20 mentions melting of the cladding material and the die surface, the following sentence indicates that the critical capability for alternative heat sources is to "quickly raise temperature *on the selected area*" (emphasis added) as distinct from heating or melting the powder.

In regard to the amendment made February 6, 2002, the paragraph of page 11 discussed above was essentially amended to insert the sentence: "To state another way, powder 16A is fed into the path while

heating the path with laser beam 10." Again, the area to which the powder is fed and the area being heated by the laser are both referenced to the "path", an area of the die body surface (not all of which can be heated by the laser or have powder supplied thereto at any given time). There is nothing in this sentence which remotely suggests that the area on which the laser beam impinges at any given time and the area to which powder is supplied are identical, but only that they correspond to the "path". The passage containing the amendment does not amend the reference to scanning of the laser beam to form a puddle which is thus necessarily different from and larger than the area on which the laser beam impinges at any given time, as clearly illustrated in Figure 2, and the added sentence of the amendment clearly does not seek to modify, much less contradict, the clear import of the remainder of the paragraph which was not significantly amended.

In regard to the Examiner's Interview Summary Record for the interview of February 4, 2002, to which the undersigned was not a party, insofar as the Interview Summary Record is relevant to the issue of direct heating of the powder by the laser, it was evidently agreed that the language "while heating said area" would be added to claim 1. In the context of claim 1 as it stood at that time, the "area" is defined as the area of the die body surface where cladding to form a blade is to be performed by heating the area with a laser. Claim 1, as it then stood, then recited (emphasis added) "introducing said blade material *into the heated area*" (note use of past tense) to which "while heating the area" was then appended, as agreed. Particularly in view of the disclosure of "scanning" the laser beam over the area, it is respectfully submitted that this language does not serve to indicate that the area to which powder is applied is congruent with the area on which the laser impinges at any given

time or that either is *congruent* with the (entire) area where cladding is being performed, particularly where the claim refers to and prefaces that language with a reference to "*heated* area" (e.g. a portion of the area which has *already* been heated by the laser and which has been further scanned to a further portion of the area).

While not questioned by Mr. Ashley, it is noted that page 11, lines 7 - 10, of the response filed February 6, 2002, shortly following the interview, contains the sentence: "By introducing the blade material directly onto the die surface in the laser beam, concurrent melting, depositing and cladding occurs by which significant amounts of material can be clad in a single pass." The sentence is in the context of supplying and depositing far more material than is contemplated by the Brown reference being discussed. It is respectfully submitted that any construction of this sentence must be made in a manner consistent with the disclosure as well as the context of the sentence and that, in so doing, the sentence must be interpreted as referring to the die surface being in the path of the laser beam while the powder is applied to the die surface (as the sentence explicitly states) at a location or area which may or may not be coincident with the point of impingement of the laser beam (which the laser could fall within). The sentence most emphatically does not indicate or suggest in any way, whatsoever, that there is any significant heating of the powder *by the laser beam* above the surface of the die body and certainly nothing which would contradict heating of the powder principally by contact with or radiation from the puddle, particularly in view of the explicit reference in the sentence to application of the powder "directly onto the die surface". Similarly, the remarks at page 10, line 10 - 18, refer (in connection with a coaxial feeder) to the powder being

applied in the "interaction *zone* of the laser and die surface" (emphasis added) and mentions that the powder could be melted just prior to or simultaneously with depositing on the die surface but, again, does not assert any significant direct heating of the powder by the laser and, significantly, omits any reference to interaction of the laser with the powder. Again, the fact remains that any powder applied, as disclosed directly to the puddle or melted portion of the die body which is of a temperature below that of the puddle as it closely approaches or reaches the puddle will extract heat from the puddle in the course of melting in the puddle *even if the area of the application of powder and impingement of the laser are, in part, coincident* and the meritorious effects of the invention can be obtained as long as the principal contribution of heat toward the melting of the powder is derived from the heat of the puddle (e.g. radiation from the puddle could, in theory, suffice for melting powder immediately above the die surface; which mechanism would still serve to control heat in the die body/puddle and the blade material as it is clad thereon).

Accordingly, it is respectfully submitted that none of the passages in the record of this application which Mr. Ashley requested that an answer be made, remotely suggest, much less require, direct heating of the powder by the laser or that the invention would not be compromised by doing so rather than by applying the blade/filler material powder to the melted puddle, as claimed. Rather, the language of the passages is repeatedly unequivocal in regard to application of the powder to the heated portion of the die body (e.g. the puddle) and inconsistent with direct heating of the powder by the laser as a characteristic feature of the successful practice of the invention to achieve its meritorious effects. No admission is seen in the

record, particularly at the points noted by Mr. Ashley for which answers were requested at the interview, which would tend to equate the invention with the references in any way, as asserted in the Examiner's statement of the current grounds of rejection which will now be discussed in detail. Moreover, at the interview, claim language was agreed upon that has been substantially adopted which clarifies and differentiates, particularly in regard to the area heated by the laser, the respective areas of cladding pattern/path, impingement of the laser, particularly in regard to "scanning" and the application of powder as well as the sequence of puddle formation and application of blade material.

Response to Asserted Grounds of Rejection

Claims 2 - 7, 10, 12 - 14, 31 and 38 - 44 have been rejected under 35 U.S.C. §103 as being unpatentable over Baker in view of Maybon. Claims 8, 9, 11, 15, 25 and 26 have been rejected under 35 U.S.C. §103 as being unpatentable over Baker in view of Maybon and Cox et al. Both of these grounds of rejection are respectfully traversed for the reasons of record and the further remarks provided below and, further, as being moot in view of the amendments made above, substantially as agreed upon at the interview discussed above.

Initially, it is noted for the record that the insertion of the language "along a further area of said path such that said powder is melted in said puddle" was agreed upon in regard to claim 38 during the course of the interview. However, upon further consideration, it is believed that a potential ambiguity might remain in such language. Therefore, the amendatory language presented above has been changed to "along a further area of *said die body corresponding to* said path such

that said powder is melted in said puddle". Otherwise the amendatory language presented above is precisely as agreed at the interview.

Baker is directed to the formation of a rotary die cutting blade by forming a weld bead on the periphery of a die surface and then machining the weld bead (though a large plurality of relatively complicated machining operations, as illustrated in Figures 3 - 8) to form the cutting blade. The Examiner admits the "mere" differences of the invention therefrom as residing in the form of the blade material and the type of heat source used to deposit the blade material which glosses the fact that Baker merely mentions that the weld bead is applied manually or by automated machinery but does not mention any technique for doing so, much less any particulars thereof or any suggestion of any technique by which a more advantageous bead shape could be derived, but, rather, merely indicates that the weld bead shape and dimensions are not critical (thus assuming that complex machining thereof will be required which is advantageously avoided by the present invention). The Examiner thus effectively ignores the recited particulars distinctive of the invention in forming a puddle in the die body and applying the blade material powder to the puddle. The Examiner does not address the compositional profile of material within the blade so formed (e.g. such that the blade and salient portions thereof, in particular, include an increased proportion of the blade material with limitation of mixing of blade material with the die body material) which is also an important meritorious effect of the invention.

In regard to the differences of the invention from Baker which the Examiner *does* recognize and admit, the Examiner relies upon Maybon for teaching laser cladding and the application of blade material as a powder but does not recognize additional important and distinctive

features of the invention which are explicitly recited in the claims, particularly as previously amended in responses filed subsequent to the Decision on Appeal of March 25, 2004.

Specifically, Maybon is directed to the surfacing or resurfacing of a "paper pulp defibering or refining plate" which is designed to grind material by ridges formed on the plate (and which the process of Maybon is intended to resurface) rather than cut material in particular shapes with a die. The height of the deposit formed by Maybon is thus relatively unimportant to the grinding *function* of the plate but is only significant to the period of use between resurfacing operations and the duration of the resurfacing operation whereas blade height is extremely important for a cutting die. The material deposited is a "*composite* material based on a hard, *abrasion resistant* material powder *bound in* a metal alloy"; the abrasion resistant material being "in the form of *grains* of tungsten carbide bound in a *brazing* alloy..." (column 4, lines 54 - 60, emphasis added). The "powder contains grains of hard abrasion resistant material which *remain solid when exposed to the laser beam* and grains of brazing alloy *which melt when exposed to the laser beam*" (column 5, lines 33 - 37, emphasis added, see also column 6, lines 4 - 9). The powder is applied by a spray nozzle which shapes the fluidized powder "into a *convergent* jet" which "must be *as closely as possible coincident* with the shape of the laser beam" in the impact area (column 5, lines 42 - 47, see also the sentence bridging columns 5 and 6). Even using a side feeder as illustrated in Figures 6 and 7 and described at column 6, lines 10 - 15, the powder application area and the area of impingement of the laser are substantially congruent and powder is clearly projected into the laser beam to be heated thereby. While column 6, lines 16 - 22, mention melting of the

surface of the plate body 8, the same sentence also indicates that the laser beam melts the brazing alloy powder and there is no mention of forming a "puddle". The following sentence explicitly states that the alloy powder (presumably the brazing alloy powder but possibly referring to the abrasion resistant material which is not melted) impinges on the surface partially melted and, evidently by virtue of the partial melting of the powder and the surface, "is trapped on the surface and melts further during *interaction of the laser beam* 28 with the plate body 8". The height of the resurfacing which can be deposited in a single pass is stated to be 0.3 mm to 1.5 mm which is much less than the 2.0 mm or greater height deposited in a single pass by the invention. Again, deposition thickness is of lesser importance to the ridge shape and function in Maybon than the width of the deposit which must match "exactly to the upper surface of the ridges" (see column 6, lines 23 - 26, and column 7, lines 9 - 11).

Thus Maybon differs from the present invention by at least teaching brazing rather than welding or cladding and, moire importantly, *critically requiring substantial melting of the brazing alloy by the laser beam*. Therefore, by relying on melting or partial melting of a portion of the powder (while the remainder comprising the abrasion resistant material is similarly heated but is never melted) by direct action of the laser beam Maybon, *teaches directly away* from the present invention in which a puddle is formed and the powder is applied to the puddle surface (and not significantly heated by the laser beam) such that the application of powder can serve as a heat control mechanism for the cladding process and, in so doing, enable formation of a deposit of advantageous shape (including incidental absence of significant surface ripples) for use as a die cutting blade and of greater height in a single pass than previously possible.

These differences from Maybon, in combination with Baker (and/or Cox et al., cited by the Examiner for heat treatment of blades after machining but not for mitigating any other deficiencies of the combination of Baker and Maybon), are reflected in the claim language by recitations (in claims 38 and 44 as currently rejected) of "heating said die body ... to form a puddle" in combination with "applying a blade material in the form of a powder to said area of said puddle to form a deposit comprising said blade material extending from said surface" which have been amended since the Decision of Appeal and as to which subsequent statements of grounds of rejection have been silent (and which forms a principal basis for a petition filed August 14, 2006; a decision on which has not been received). This language has been further clarified in the amendments made above substantially in accordance with the interview with Mr. Ashley to recite (using claim 38 as an example, similar amendments having been made in claims 13 and 44):

> "a) heating an area of said die body ~~with~~ by scanning a laser to form a puddle of melted die body material in ~~an~~ said area in the surface of said die body along a path corresponding to said pattern;
>
> "b) upon forming said puddle, applying a blade material in the form of a powder to ~~said area of~~ said puddle while continuing said step of heating said die body along a further area of said die body corresponding to said path such that said powder is melted in said puddle to form a deposit comprising said blade material extending from said surface".

Accordingly, it is respectfully submitted that a *prima facie* demonstration of obviousness has not been made in regard to any claim in the application and that the

asserted grounds of rejection are particularly untenable in regard to the claims as amended above.

Moreover, there is no appearance that any amendatory language presented in any response since June 17, 2005, has been properly considered. Rather, in the current office action, the statement of the rejection remains silent in regard to those features and while the Examiner, in response to previous arguments, quotes the claim language "applying a blade material in the form of a powder to said area of said puddle while continuing said step of heating said die body for form (sic) a deposit comprising said blade material extending from said surface" but then merely indicates that since Maybon mentions melting of a surface, a "puddle" is inherent while *remaining silent in regard to the recitation of application of powder to the puddle*.

The following three paragraphs (pages 6 - 8) of the current office action seek to interpret the specification of the present application to conform to Maybon and contrary to the explicit terms thereof and their context; asserting that differences in areas impinged upon by the laser and the area of the puddle to which the powder is applied has no support in the original specification which is clearly incorrect, particularly in view of Figure 2 and passages discussed above in response to Mr. Ashley's request. It is respectfully submitted that while the deposits of Maybon as shown in Figure 8 thereof might possibly be described as "half elliptical" (although Maybon does not so describe them and the deposits are not upstanding as illustrated in Figure 3 of the application but more in the generally flattened shape of the weld bead of Baker) they are certainly not of "near net shape" since the entire curved upper portion of the deposit must be removed to restore a rectangular shape to the plate ridges as shown in Figure 9 and/or

16 (see column 6, lines 51 - 63) of Maybon. Therefore, rather than being of near net shape for use as a die blade, the deposits produced in Maybon are no more appropriate to die cutting than the weld beads of Baker and neither Baker nor Maybon remotely contemplates, much less enables, production of a deposit shape capable of limiting the amount of machining required to obtain a desired blade shape/profile.

In view of the foregoing, it is respectfully submitted that the Examiner has not properly considered the scope and content of the prior art in regard to the claimed subject matter taken as a whole and has effectively ignored recitations of the claims which clearly support meritorious functions of the invention. For example, the Examiner has not recognized that Baker is virtually devoid of details of the welding process and is apparently forming weld beads in an otherwise well-known manner while the Examiner has not considered previously submitted amendatory claim language, particularly in regard to the application of powdered blade material to the puddle formed by heating by a scanning laser or that the puddle or portion thereof must be formed prior to application of powdered blade/filler material thereto.

Moreover, the Examiner has interpreted the disclosure to conform to Maybon and relied on that erroneous interpretation in order to construe the claims and has done so contrary to the clear import of explicit description and illustration therein in order to colorably justify such improper consideration of the claimed subject matter taken as a whole and improper determination of the scope and content of the prior art and the clear and the explicitly recited claimed differences between the invention and the prior art which support the meritorious effects of the invention which are also clearly distinct from that of Maybon taken alone or in combination with Baker and/or Cox et

al. The possible incidental overlap of the laser impingement area with the area where powder is applied and consequent incidental heating of some portion of the powder by the laser does not lessen the fact that the invention is fully, clearly and patentably distinguished from the prior art by the application of powder to the puddle where the laser is not directly impinging and thus serves as a further mechanism of heat control having the meritorious effects of creating an advantageous near net shape of the bead and advantageous compositional profile while the prior art teaches directly away from that distinction by *requiring* laser heating of the powder and do not suggest, much less achieve, the meritorious effects of the invention.

Further, the Examiner has not appreciated that Baker and Maybon are largely non-analogous in regard to not only the types of blades developed and properties which would be desirable for the respective different types of blades but the method by which they are formed: Baker by welding and Maybon by brazing. The Examiner has also failed to recognize that none of the prior art relied upon leads to any expectation of success in achieving a deposit of near net shape for a die cutting blade and which deposit comprises blade material (as distinct from a significant mixing of blade and die body material) where it extends from the die body or, that Maybon teaches directly away from the present invention since it *requires* the heating of powdered blade material by the laser and that operation of Maybon in the intended manner would be precluded if modified to answer the claimed subject matter or, for that matter, to produce the die cutting blade of Baker. See In re Gordon, 221 USPQ 1125 (Fed. Circ., 1984).

It is also respectfully submitted that any of the above deficiencies in the statements of the grounds of rejection by the Examiner is sufficient to preclude a

prima facie demonstration of obviousness from being made. Moreover, it is abundantly evident in view of the above-discussed deficiencies in the rejection of the claims that the Examiner has failed to make such a *prima facie* demonstration of unpatentability and the asserted grounds of rejection are clearly untenable, particularly in view of the amendments made above.

The references of record relied upon therein simply do not provide evidence of a level of ordinary skill in the art which would support a conclusion of obviousness in regard to any claim in the application but, rather, the actual and respective deficiencies of each reference considered in comparison to the claimed subject matter and each other, seems to clearly indicate that a hindsight reconstruction of the invention has been attempted that does not, in fact, answer the explicitly recited subject matter of the claims and which is, as demonstrated above, well-supported by the original disclosure. Further, the Examiner's clearly erroneous interpretation of the disclosure and construction of the claims, effectively ignoring explicit and unambiguous recitations therein, does not recognize that the meritorious effects supported thereby which are not available from the combination of prior art applied are, indeed unexpected and, as such, is a primary indicator of patentability as well as being a secondary indicator of patentability in satisfying a long-felt need for reduced machining of the weld bead once formed which the reference relied upon do not address. Accordingly, reconsideration and withdrawal of the grounds of rejection of record are respectfully requested.

Since all rejections, objections and requirements contained in the outstanding official action have been fully answered and shown to be in error and/or inapplicable to the present claims, it is respectfully submitted that reconsideration is now in order under

the provisions of 37 C.F.R. §1.111(b) and such reconsideration is respectfully requested. Upon reconsideration, it is also respectfully submitted that this application is in condition for allowance and such action is therefore respectfully requested.

If an extension of time is required for this response to be considered as being timely filed, a conditional petition is hereby made for such extension of time. Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,

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Attachments:
- Pages 127 - 130 of "Welding and Its Application" by B. E. Rossi, McGraw-Hill, 1941
- Comparative photographs (A - H) of welds

WELDING

AND

ITS APPLICATION

BY

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PREFACE

The art of welding has made great progress in the past few years, and today it is one of the most important tools for manufacturing, construction, and maintenance purposes.

The object of this book is (1) to familiarize the beginner with certain fundamental facts concerning the welding process, (2) to give the experienced welding operator a wider understanding of the welding process, and (3) to provide a source of reference for the draftsman, designer, engineer, executive, and anyone else interested in the application of welding. Although emphasis has been placed on electric-arc welding, an attempt has been made to give a picture of the welding industry as a whole.

The author has at times drawn freely from the works of well-known welding organizations, and he wishes to take this opportunity to express his sincere gratitude to all those who so generously cooperated with him in the assembling and preparation of the material. He is especially indebted to the American Welding Society, the International Acetylene Association, Lincoln Electric Company, General Electric Company, Westinghouse Electric and Manufacturing Company, Hobart Brothers Company, Wilson Welder and Metals Co., Air Reduction Sales Company, Linde Air Products, and many other organizations whose names do not appear here. He also feels deeply grateful to the Welding Division of the Delehanty Institute, to his colleagues, to his most valued friend, Frederick R. Weaver, and to his beloved wife, Victoria, for their invaluable assistance.

BONIFACE E. ROSSI.

NEW YORK,
August, 1941.

trode to the work. Upon the latter may depend the freedom from u... cutting and slag inclusion, the ease with which the filler metal is p... in the weld, the uniformity of fusion, and the weld contour as aff... by the influence of surface tension and gravity of the molten meta... Fig. 151).

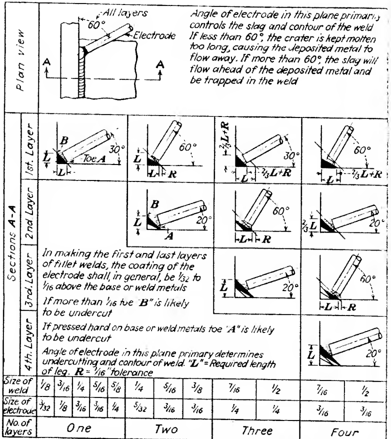


Fig. 151. – Deposition technique for standard 45 deg. covered electrode fillet welds.

Weaving the Electrode.— In depositing weld metal, it is often desira... to make the width of the deposit wider than that obtained by a str... bead. In such cases a weaving motion is applied to the electrode as it ... advanced along the line of weld (see Fig. 152). By weaving, it is possib... to deposit more metal at a single pass, not only in welding in a Vee groo... on heavy plates, but also in making a fillet weld or in building up a p...

There are a number of different weaving motions used in welding, b... in all cases it is important that the motion be uniform. If the weave us...

... uniform or close enough, there is danger of poor fusion at the edges ... deposit (see Fig. 153).

Polarity. – The term *polarity* in welding may be attributed to the fact ... every electrical circuit has a negative and a positive terminal or pole.

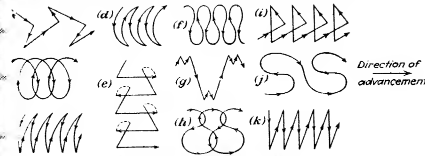


Fig. 152. Typical weaving motions.

In a d.c. circuit, the current flows in one direction only. The line that ...ries current from the supply is called the "positive" side; the line that ...urns the current to the supply is called the "negative" side. It is ...eved that approximately 60 to 75 per cent of the heat is liberated at

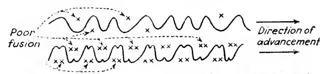


Fig. 153. Result of beads' not being uniform or close enough.

... positive side of the circuit and 40 to 25 per cent at the negative side. ...ce the mass of the work to be welded is usually larger than the mass ... the electrode, it is desirable to have more heat liberated in the work ...n in the electrode, so that both may reach the fusing point at the same

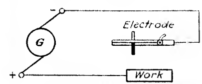


Fig. 154. – Connections for straight polarity.

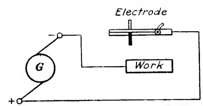


Fig. 155. – Connections for reversed polarity.

...me. Therefore, in d.c. welding with bare or lightly coated steel elec...odes, the workpiece is usually connected to the positive side of the ...rcuit and the electrode is attached to the negative side. The condition ... referred to as *straight polarity* (see Fig. 154).

However, in some cases, such as in joining thin material, in welding cast iron, and in using certain types of heavily coated ferrous and nonferrous electrodes, the work is made negative and the electrode positive. This condition is known as *reversed polarity* (see Fig. 155).

With the carbon electrode, straight polarity should always be used. With reversed polarity, the arc is extremely unstable, and particles of carbon are deposited on the work. Also, there is a good possibility of the carbon monoxide given off by the electrode coming in contact with the molten metal, being absorbed, and thus carbonizing the base metal and making it hard. This is especially true in the welding of steel.

In using a.c. welding machines, no choice of polarity is made, for it is the characteristic of alternating current to change its polarity many times a second. For this reason, it is not possible to use a.c. machines for all types of welding. For instance, alternating current cannot be used for bare-electrode welding and is rather difficult to use for carbon-arc welding.

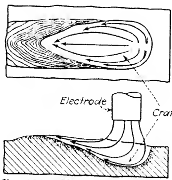


Fig. 156.—Diagram showing flow of metal when welding.

To facilitate the reversing of the polarity of the electrodes, most modern machines are provided with a reversing polarity switch. If a machine is not so equipped, then the welding cables on the terminal lugs of the generator must of necessity be reversed. This means that the electrode-holder cable would be attached where the ground cable was originally and that the ground cable would be connected where the electrode-holder cable originally was.

If no other means are available, the existing polarity hookup of a welder can easily be determined by striking an arc with a carbon electrode. If the arc is easily maintained when drawn away from the work, the hookup is that of straight polarity; if the arc breaks and is difficult to maintain, then the hookup is that of reversed polarity.

Arc Crater and Penetration.—At the point where the arc strikes the plate, if the current, polarity and speed of travel are correct, the metal is melted and forms a pool of molten metal. This molten metal seems to be forced out of the pool by some sort of blast from the arc. A small depression is thus formed in the base metal, and the molten metal is piled up around the edge of the depression which is referred to as the *arc crater* (see Fig. 156).

The size and depth of craters are dependent upon temperature, oxidation, surface tension, and other factors affecting fusion.

Weld craters are due to the pressure of the expanding gases and of the electron stream from the electrode tip and to the higher temperature at the center of the crater. The pressure of the expanding gases and of the electron stream blows the liquid metal toward the edges of the crater, and the higher temperature at the center of the crater results in a lower surface

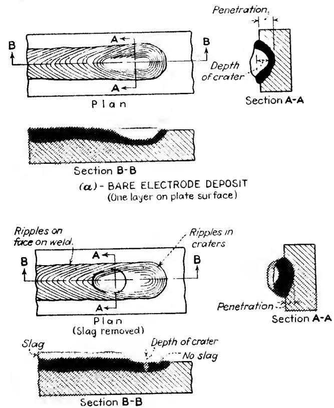


Fig. 157 Typical shielded and unshielded metal-arc craters.

tension at that point, in comparison with the lower temperature and higher surface tension at the sides of the crater and adjacent metal. The equilibrium of the crater metal is upset by this difference in surface tension, and concentric waves result which freeze on reaching the colder edges or rim. This phenomenon can easily be noted during welding, and all completed welds have rippled faces. The angularity of the electrode

and the speed of welding determine the contour of the ripples (see Fig. 157).

During welding, the depth of the crater provides a means of observing the "penetration," or the depth to which the arc extends in the original metal (see Fig. 158). The depth of penetration should be one-third to one-half the total thickness of bevel and not less than $\frac{1}{16}$ in. Since fusion of the original metal is one of the requirements of a good weld, the soundness of the weld may be predicted from the penetration. However, the depth of a crater in a completed weld is not a definite indication of the depth of fusion or penetration; for craters of properly shielded processes are relatively shallow, and the crater may have been intentionally filled when the arc was broken.

The lack of a crater during welding is definite evidence that more heat must be generated for the parent metal to melt sufficiently to receive in fusion the molten metal from the filler rod.

(a)-Covered electrode deposit (b)-Bare electrode deposit

Fig. 158. Typical penetration obtained with coated (or covered) and bare electrodes. (One layer deposition.)

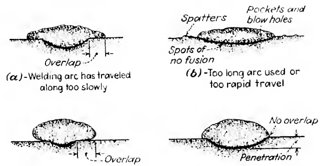
Arc Length and Arc Voltage.—There are three well-defined voltage zones in the welding arc: (1) cathode voltage drop; (2) anode voltage drop at the terminals; (3) the arc-stream voltage. The heat dissipated in each is in proportion to the voltage. The cathode and anode voltage drops remain practically constant and independent of the arc length and current. The arc-stream voltage varies with the arc length, but not in exact proportion thereto.

Good welds are not ensured by correct arc lengths only; but a long arc results in a poor weld, especially in welding with bare or lightly coated electrodes. The work is heated by the release of energy at the terminal of the arc, by the radiation and conduction from the arc core and stream, by the radiation from the hot surface of the electrode, and by the hot metal deposited upon it. If a short arc is used, the heat is concentrated upon the plate; with a long arc, a great deal of the heat is lost into the surrounding area. Thus, a short arc transforms a greater portion of the energy into useful heat.

A long arc tends to wander over a considerable area on the work, and the arc flame blows about very rapidly; in other words, it is unstable. Because of this unstable condition of the arc and the greater length of the arc, the air has considerable opportunity to come in contact, not only with

the metal passing from the electrode to the plate, but also with the very hot metal in the pool or crater. The hot metal thus absorbs oxygen and nitrogen, both of which are detrimental to the quality of the weld. With a short arc, the flame, consisting of vapors coming out of the arc, acts as a protection by surrounding the electrode metal and the arc pool, the absorption of these outside gases being thus largely prevented.

In shielded-arc welding, however, a longer arc may be used. As seen previously, the outside covering, burning more slowly than the electrode core, forms a protecting sheath and thus tends to prevent unstable conditions of the arc, as well as oxidation. The deposited weld metal is also protected from the atmosphere and from subsequent oxidation by a certain amount of slag that is formed on top of it.



(a)-Welding arc has traveled along too slowly (b)-Too long arc used or too rapid travel

(c)-Not enough heat used (d)-Weld which is satisfactory

Fig. 159. Cross section of beads deposited under different conditions.

A long arc, besides causing welds of low strength, poor ductility, and high porosity, also prevents concentration of the deposit and causes excessive overlap, splattering and waste of material.

The kind and diameter of electrode and the current used determine the correct length of the arc. In bare-electrode welding the arc length should generally be approximately the same as the diameter of the electrode. Longer arcs are required by larger electrodes and higher currents.

Vertical, horizontal, and overhead welding require a shorter arc than flat welding. In the flat position, the normal arc voltage is 15 to 25 volts for $\frac{1}{8}$ to $\frac{1}{4}$-in. bare and lightly coated electrodes and 22 to 45 volts for coated electrodes. The voltages for the other welding positions are 2 to 5 volts less. With bare or lightly coated electrodes, a 15-volt arc is about $\frac{1}{8}$ in. long; with coated electrodes, a 40-volt arc is approximately $\frac{1}{4}$ in. long. For carbon-arc welding, the length of the arc is greater than for metallic-arc welding, usually ranging from $\frac{3}{8}$ to $\frac{7}{8}$ in., according to the current used. With a stable and proper carbon arc, a slight hissing sound is given off.

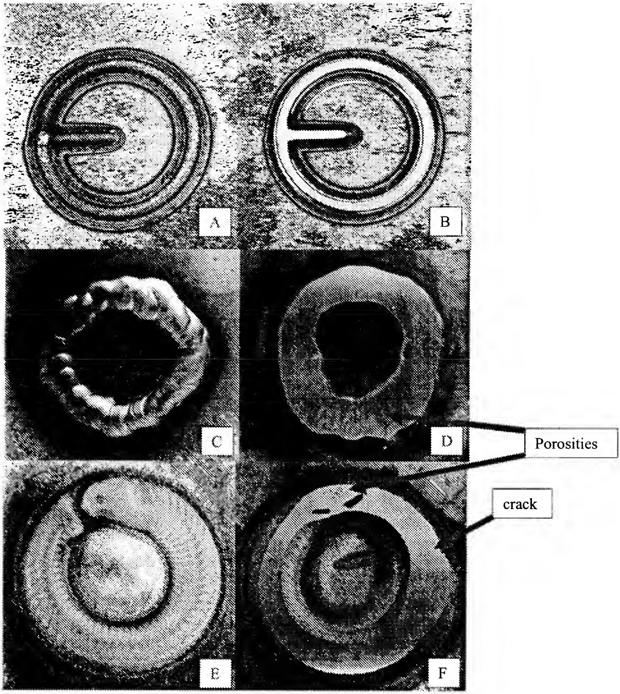
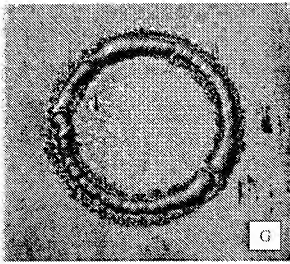
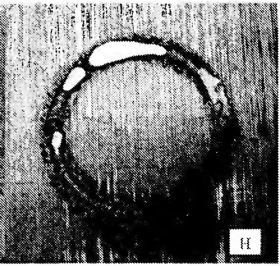


Figure 5 Deposits from laser, arc welding and plasma powder deposition

A – As deposited laser deposition
B – Surface ground laser deposition
C – As deposited arc welding deposition
D – Surface ground arc welding deposition
E – As deposited plasma arc deposition
F – Surface ground plasma arc deposition



G – As deposited when melting powder first Before the molten paddle was formed at the substrate. Spattering and incomplete bounding and inconsistent of melting become a disaster. The bead could not be used for our application.



H – Surface ground for G. As been seen some area of the bead was not tall enough and was a complete disaster.